REMARKS/ARGUMENTS

Favorable reconsideration of this application as presently amended and in light of the following discussion is respectfully requested.

Claims 1-5, 7-9, 11-24, 27, and 28 are pending in the present application. Claims 1, 2, 4, and 5 have been amended by the present response, and support for the amendments is found in the Applicants' specification at least at page 7, lines 28-31. The present claim amendments are consistent with discussions during a personal interview held with Examiner Fastovsky on January 8, 2004 regarding the previous Office Action. Further, since all elements of the claims were either earlier claimed or discussed as examined, Applicants respectfully request that the Examiner enter the amendment on the record. Further, the Applicants note that entry of the amendment will place the application in better form for appeal. It is respectfully submitted that no new matter is added by this amendment.

In the outstanding Office Action, Claims 1-5 and 27-28 were rejected under 35 U.S.C. §102(b) as being anticipated by or, in the alternative, under 35 U.S.C. §103(a) as obvious over Kawada et al. (U.S. Patent Number 5,665,260, hereinafter Kawada); Claims 1-4, 9, 21-23, and 27-28 were rejected under 35 U.S.C. §103(a) as being unpatentable over Bogdanski et al. (U.S. Patent Number 6,150,636, hereinafter Bogdanski); Claims 5, 7, 11, and 24 were rejected under 35 U.S.C. §103(a) as being unpatentable over Bogdanski in view of Miyata (U.S. Publication Number 2002/0021730) or Noda et al. (U.S. Patent Number 5,753,893, hereinafter Noda); Claims 8 and 12 were rejected under 35 U.S.C. §103(a) as being unpatentable over Bogdanski in view of Miyata and further in view of Yamada et al. (U.S. Patent Number 5,998,320, hereinafter Yamada); Claims 13-16 were rejected under 35 U.S.C. §103(a) as being unpatentable over Kawada in view of Ushikawa et al. (U.S. Patent Number 6,140,256, hereinafter Ushikawa); Claims 17-19 were rejected under 35 U.S.C. §103(a) as being unpatentable over Bogdanski in view of Kariya et al. (U.S. Patent Number 6,452,137,

hereinafter Kariya); and Claim 20 was rejected under 35 U.S.C. §103(a) as being unpatentable over Bogdanski in view of Miyata and Kariya.

Applicants thank Examiner Fastovsky for the interview granted Applicants' representatives on August 25, 2004. During the interview, the claimed invention was discussed with respect to the cited references. More specifically, the surface roughness of the present invention was discussed with respect to Kawada which does not disclose a surface roughness and Bogdanski which discloses a macrounevenness. The present response sets forth the claim amendments and arguments previously discussed during the interview.

Before turning to the outstanding art rejections, it is believed that a brief review of the invention would be helpful. The present invention relates to a ceramic heater including a ceramic substrate having a work-heating surface and a heating element disposed either on or in the ceramic substrate. The work-heating substrate is configured "to contact directly with a work to be heated or to face a work to be heated across a space between the work-heating surface and the work to be heated." In Claim 1, the work-heating surface "has a JIS B 0601 surface roughness of Rmax = 0.05 to 200 μm;" in Claim 2, "said ceramic substrate contains an element other than its dominant constituent elements and the work-heating surface has a JIS B 0601 surface roughness of Rmax = 0.2 to 200 μm;" in Claim 4, the ceramic substrate is a nitride ceramic substrate, and "said nitride ceramic substrate contains an element other than its principal constituent elements and the work-heating surface has a JIS B 0601 surface roughness of Rmax = 0.2 to 200 μm;" and in Claim 5, "said nitride ceramic substrate contains at least one element selected from Na, B, Y, Li, Rb, and Ca and the work-heating surface has a JIS B 0601 roughness value of Rmax = 0.2 to 200 μm."

Through the inventors' own inventive efforts, the cause-and-effect relationship between the surface roughness of the work-heating surface and obtaining a uniform temperature of the work was discovered, thereby achieving an innovative ceramic heater

which can heat the work to a uniform temperature by adjusting the surface roughness Rmax of the work-heating surface within a specified range.

If the surface roughness of the work-heating surface is too small, the area of contact between the work and the work-heating surface becomes too large when the work is placed and heated on the work-heating surface. The temperature difference in the work-heating surface is reflected to the work, and the temperature difference in the work becomes large (see attached Fig. 1B). Even when the work is held apart from the work-heating surface, the atmospheric gases (air, reactive gas, and the like) between the work and the work-heating surface flow easily to the work and deprive the work of heat, and the result is that a temperature difference is generated in the work (see attached Fig. 1D).

Conversely, if the surface roughness of the work-heating surface is too large, atmospheric gases remain in the spaces among the irregularities of the work-heating surface (valleys) or at the spaces between the work and the work-heating surface. This causes accumulation of heat and leads to a large temperature difference of the work (see attached Figs. 1A and 1C).

The above effects are shown in a comparison of exemplary examples included in the Applicants' specification. In exemplary Comparative Example 7, wherein Rmax is 210 μm, the temperature difference of the work, that is, the difference between the highest and the lowest temperatures was as big as 8°C.[1] In exemplary Comparative Example 6, Rmax is as small as 0.03 μm, but the difference between the highest and the lowest temperatures was also as big as 8 °C.[2] Conversely, in the corresponding exemplary examples, the temperature differences of the work were small: in Example 8 with (Rmax = 0.08 μm), the difference was 4°C; in Example 9 (Rmax = 6 μm), it was 3°C; in Example 10 (Rmax == 180 μm), it was 4°C. The importance of the dependency of the relationship between the surface roughness of

[1] Applicants' specification, page 36, lines 26 to 31 (results are shown in Table 2 on page 39).
[2] Applicants' specification, page 29, lines 21 to 25 (results are shown in Table 2 on page 39).

the work-heating surface and uniform heating of the work is clear from the above results, and these comparative results must be given weight as evidence, not mere arguments. See In re Margolis, 228 U.S.P.Q. 940 (Fed. Cir. 1986). It is further noted that evidence of superiority, like these comparative examples, is enough to establish nonobviousness. See In re Chupp, 2 U.S.P.Q. 2d 1437, 1439 (Fed. Cir. 1987). Therefore, as the above discussed effect of the present invention is unexpected and not found in any of the cited references, the withdrawal of the rejections in the outstanding Action is believed to be in order.

The rejection of Claims 1-5, 27, and 28 under 35 U.S.C. §102(b) as being anticipated by or, in the alternative, under 35 U.S.C. §103(a) as obvious over Kawada is respectfully traversed as discussed below.

Kawada discloses a heater comprising: a supporting ceramic substrate having opposite first and second surfaces; a heat generating layer on the first surface; an electrode layer on the second surface; and a covering layer covering the electrode layer and the heat generating layer. The surfaces of the supporting substrate, the electrode layer, and the heat generating layer have a surface roughness Rmax of at least 5 μm.[3] (See the attached Fig. 2) However, since the covering layer is interposed between the electrode layer, the electrode layer is not configured to contact directly with a wafer or to face the wafer across a space between the wafer and electrode. Further, the outer surface of the covering layer of Kawada corresponds to the work-heating surface of the present invention, and Kawada does not disclose any particular surface roughness Rmax for this covering layer on which the work is placed. Therefore, Kawada does not disclose, teach or suggest the surface roughness of the work-heating surface of the ceramic heater presented as part of the subject matter of Claims 1-5, 27, and 28. Further, it should be noted that Kawada does not disclose, teach, or suggest the

[3] Kawada, column 3, lines 36-45.

dependency between the surface roughness of a work-heating surface and the uniformity of heating produced as to the work being heated using the work-heating surface.

Kawada addresses the problem that separation takes place between the bonded layers of an electrostatic chuck with a built-in heater.[4] In order to solve this separation problem, Kawada formed a supporting substrate, an electrode layer and a heat generating layer to all have a surface roughness Rmax of 5 μm or larger.[5] In summary, Kawada improves the physical bonding strength of bonded parts of the supporting substrate, the electrode layer, the heat generating layer, and the covering layer by roughening surfaces of the supporting substrate, the electrode layer and the heat generating layer. However, Kawada does not disclose, teach, or suggest uniform heating of a work as described in the subject matter of Claims 1-5, 27, and 28, much less the cause-and-effect relationship between the surface roughness Rmax of the work-heating surface and the obtaining of a uniform temperature of the work. Therefore, the subject matter of Claims 1-5, 27, and 28 is neither anticipated by nor obvious over Kawada.

Addressing now the rejection of Claims 1-4, 9, 21-23, and 27-28 under 35 U.S.C. §103(a) as being unpatentable over Bogdanski, that rejection is also respectfully traversed.

In Figure 1, Bogdanski discloses a cooking system having an electric hotplate. The hotplate 11 includes a hot plate body 14 of nonoxidic ceramic, preferably silicon nitride, a heating means 17, and a thermal insulation 18. Further, Bogdanski discloses that the macro-unevenness and micro-unevenness of the upper cooking surface 23 of the hot plate body differ by no more than 0.1 mm, and preferably by no more than 0.05 mm from an ideal plane.[6] The same requirements apply for the lower surface 24 of a cooking vessel 25 placed thereon, "so that the naturally always present microgap 26 between the surfaces 23 and 24 is

[4] Kawada, column 1, lines 37-41.
[5] Kawada, column 2, lines 51-60.
[6] Bogdanski, column 6, lines 51-54.

approximately between 0 mm and a max 0.2 mm."[7] Bogdanski also discloses that a smaller amount of unevenness is preferable for surfaces 23 and 24. However, Bogdanski does not teach or suggest an Rmax of the upper cooking surface 23. As shown by a broken line in the attached Fig. 3A, unevenness of a surface is indicated by a line connecting peaks of irregularity (mountains) in the surface, whereas Rmax is the difference of height between the highest peak and the deepest valley (see attached Figs. 3A-3B). The effect of the present invention is not achieved by reducing the amount of unevenness, but is achieved by adjusting the Rmax within a specific range. Therefore, it is not foreseeable from Bogdanski that a work can be heated uniformly by adjusting the surface roughness, Rmax, of the work-heating surface within a specific range, much less is there any reason that the artisan would consider Bogdanski to teach or suggest any concern with Rmax. Thus, Bogdanski does not teach or suggest the constitution and the effect of the subject matter of Claims 1-4, 9, 21-23, and 27-28, and the present invention defined by these claims is not obvious over Bogdanski.

The rejection of Claims 5, 7, 11, and 24 under 35 U.S.C. §103(a) as being unpatentable over Bogdanski in view of Miyata or Noda is respectfully traversed for the reasons noted below.

Miyata discloses "An electric heating element having a structure comprising an electric insulating nitride or carbide ceramic substrate and an electrically heat-generating material film having a microstructure composed of silicide alone, a mixture of a silicide and Si, or Si alone, said film being fused to the surface of said electric insulating ceramic substrate."[8] Further, Miyata discloses an electrostatic chuck having a structure comprising an electrostatically chucking mechanism provided with a dielectric ceramic and an electrode formed on the bottom face of said dielectric ceramic and a heating mechanism coupled with the bottom face of said electrostatically chucking mechanism, said heating mechanism having

[7] Bogdanski, column 6, lines 57-60.
[8] Miyata, page 2, paragraph 31.

a structure comprising two electric insulating ceramic substrates having the same or nearly the same linear expansion coefficients and a fusable electric-heating material film interposed between said substrates, said film being fused to said substrates.[9] However, Miyata does not teach or suggest the claimed surface roughness, Rmax, of the heating surface. Therefore, Miyata does not cure the deficiencies as discussed above with respect to Bogdanski.

Further, the Office Action mailed March 30, 2004 states on page 3, paragraph 4 that "Miyata teaches elements Ca and Y in a ceramic heater that is in amount less than 0.5 weight %." However, Miyata teaches that a film disposed on the oxide ceramic substrate contains an active metal in the amount of not less than 0.5% on the surface.[10] Miyata does not teach or suggest anything about the content of metal in an oxide ceramic substrate.

Miyata further teaches that a nitride ceramic substrate can be used in the electric heating element, and the electrically heat-generating material has a microstructure composed of a mixture of silicide and Si.[11] Regarding the above-mentioned silicide, Miyata teaches that the silicide is formed by a reaction of an element X with Si, and the microstructure of X-Si alloy changes with the change in Si content.[12] Example Compositions (1) to (4) are discussed in paragraphs [0077] to [0080] of Miyata. For the element X in the X-Si alloy, Cr, Mo, W, Fe, Ni, Co, B, P and active metal, and Pt, Pd, Rh, Ir, Cu, Ag and other silicide forming elements may be selected depending on the application.[13] Further, Miyata states among the other silicide forming elements, active metals are preferred.[14] V, Nb, Ta, Ti, Zr, Sf, Y, Mn, Ca, Mg, rare earth elements, aluminum and other elements are referred to as active elements which are capable of wetting ceramics to accelerate diffusing.[15] In summary, Miyata teaches the use of X-Si alloy as a material for the **resistance heat-generating material film**, and

[9] Miyata, page 2, paragraphs 40-41.
[10] Miyata, page 2, paragraph 36.
[11] Miyata, page 2, paragraphs 33-34.
[12] Miyata, page 3, paragraph 76.
[13] Miyata, page 4, paragraph 91.
[14] Miyata, page 4, paragraph 93.
[15] Miyata, page 9, paragraph 196.

teaches about metals contained in **the resistance heat-generating-material film** (emphasis added), not about any metal content of the ceramic substrate. Conversely, the nitride ceramic substrate contains at least one element selected from Na, B, Y, Li, Rb and Ca as recited in Claim 5. Therefore, Miyata also does not teach or suggest that the ceramic substrate contains active metals such as Ca or rare earth elements.

Noda discloses a ceramic heater having a resistance heater and a sintered material comprising Al_2O_3, SiO_2, MgO and CaO, and further comprising 0.3 to 13% by weight of at least one oxide of an element selected from the group consisting of Zr, Y, Hf, Nb, and Ta.[16] Figures 1 and 2 show a planar plate-shaped heater and a round-rod shaped heater. However, Noda does not teach anything about the claimed surface roughness, Rmax, of the work-heating surface.

As discussed above, Bogdanski, Miyata, and Noda do not teach or suggest the claimed surface roughness Rmax set within a specified range. Since Bogdanski, Miyata, and Noda, either alone or in any proper combination, do not teach or suggest the constitution and the effect of the subject matter of Claims 5, 7, 11, and 24, these claims cannot be said to be obvious over Bogdanski, Miyata, and Noda or any proper combination thereof. Therefore, the rejection relying on these references are respectfully traversed.

The rejection of Claims 8 and 12 under 35 U.S.C. §103 (a) as being unpatentable over Bogdanski in view of Miyata and further in view of Yamada is further respectfully traversed as discussed below.

Yamada discloses an aluminum nitride sintered body comprising aluminum nitride and less than 100 ppm of metal elements other than aluminum, wherein the sintered body has a volume resistivity at room temperature greater than $1.0 \times 10^9\ \Omega\cdot$cm and smaller than $1.0 \times$

[16] Noda, column 2, lines 22-55 and column 9, lines 22-28.

$10^{13}\ \Omega\cdot cm$.[17] Yamada also discloses an electrostatic chuck comprising a resistance heating member 21 embedded in the supporting portion 8, which is the aluminum nitride sintered body.[18] Further, Yamada teaches that the amount of Si, Fe, Ca, Mg, K, Na, Cr, Mn, Ni, Cu, Zn, W, B or Y comprised in aluminum nitride powders is smaller than 100 ppm, respectively.[19] In Yamada, a volume resistivity of the sintered body is extremely decreased by adjusting the amount of total metal elements other than aluminum in the sintered body.[20] However, Yamada is silent about the surface roughness, Rmax, of the work-heating surface. Therefore, Yamada does not cure the deficiencies as discussed above with respect to Bogdanski and/or Miyata, and therefore, the subject matter of Claims 8 and 12 cannot be said to be obvious over Bogdanski in view of Miyata and further in view of Yamada.

Further, it should be noted that Yamada is also silent about the problem of contaminating a semiconductor wafer by metal elements other than aluminum. The contamination problem is inherent in Yamada, and Yamada does not teach a solution to the contamination problem. Conversely, the claimed subject matter includes a solution for the contamination problem inherent in Yamada As described in the specification, the vaporization of Y, Na, etc. from the wafer-heating surface can be prevented by roughening the wafer-heating surface.[21]

The rejection of Claims 13-16 under 35 U.S.C. §103(a) as being unpatentable over Kawada in view of Ushikawa is further respectfully traversed for the reasons noted below.

Ushikawa relates to an apparatus for processing semiconductor wafers. According to Ushikawa, the bottom surface of a wafer can be positioned above the mount surface of the apparatus by a distance of 0.5 mm to 2 mm.[22] However, Ushikawa is silent about the surface

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[17] Yamada, Abstract.
[18] Yamada, column 8, lines 62-67 and Figure 4.
[19] Yamada, column 15, lines 39-42.
[20] Yamada, column 16, lines 9-12.
[21] Applicants' specification, page 3, lines 9-11.
[22] Ushikawa, column 4, lines 33-36.

roughness, Rmax, of the mount surface. Further, Ushikawa does not teach or suggest the cause-and-effect relationship between the surface roughness of the mount surface and obtaining a uniform temperature of the work. Therefore, Ushikawa does not remedy the deficiencies as discussed above with respect to Kawada. Accordingly, the subject matter of Claims 13-16 is also not obvious over Kawada in view of Ushikawa.

The rejection of Claims 17-19 under 35 U.S.C. §103(a) as being unpatentable over Bogdanski in view of Kariya is respectfully traversed for the following reasons.

Kariya discloses a ceramic heater comprising a ceramic substrate and a heating body made of a non-sintering metal foil or an electrically conductive ceramic thin film.[23] Preferable, aluminum nitride with a thermal conductive coefficient of 180 W/mK is used for the ceramic substrate.[24] However, Kariya is also silent about the surface roughness, Rmax, of the work-heating surface and the cause-and-effect relationship between the surface roughness of the work-heating surface and a uniform temperature of the work. Therefore, Kariya does not remedy the deficiencies as discussed above with respect to Bogdanski, and the subject matter of Claims 17-19 cannot be said to be obvious over the combination of Bogdanski and Kariya as suggested in the outstanding Action.

Addressing now the rejection of Claim 20 under 35 U.S.C. §103(a) as being unpatentable over Bogdanski in view of Miyata and Kariya, that rejection is also respectfully traversed for the reasons set forth below.

As discussed above, Bogdanski, Miyata, and Kariya, considered alone or together in any proper combination, do not teach or suggest the claimed surface roughness, Rmax, of the work-heating surface being within a specified range, much less any hint that this claimed surface roughness will achieve a ceramic heating device capable of uniformly heating a work.

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[23] Kariya, Abstract.
[24] Kariya, column 4, lines 29-42.

Therefore, the subject matter of Claim 20 cannot be said to be obvious over Bogdanski, Miyata, and Kariya, considered alone or together in any proper combination.

Further, the Applicants wish to respectfully inform the Examiner that Japanese Patent JP 3536256, concerning the corresponding Japanese application JP2001-515657, evidence that the novelty and unobviousness of the present claimed subject matter has been acknowledged.

Consequently, in view of the present amendment and in light of the above comments, no further issues are believed to be outstanding in this application, and the present application is believed to be in condition for formal allowance. An early and favorable action to that effect is respectfully requested.

Respectfully submitted,

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